REMARKS

This communication is a full and timely response to the final Office Action dated April 8, 2005 (Paper No./Mail Date 20050331), and is submitted concurrently with a Request for Continued Examination. By this communication, claim 15 has been added.

Claim 15 recites an image processing apparatus for converting the resolution of an original image in such a manner as to increase the spatial resolution of said original image by a factor of Z in each of vertical and horizontal directions, said image processing apparatus comprising energy calculating means for calculating local energy of said original image based on two rows of pixels in said original image, wherein calculation of the local energy includes calculating differences between pixels of the two rows, calculating absolute values of the differences, and summing the absolute values of the differences; detection means for detecting the direction of an edge based on said local energy calculated by said energy calculating means; interpolation means for interpolating a new pixel from a pixel of said original image based on the direction of the edge detected by said detection means; and edge enhancement means for performing an edge enhancement process based on said local energy calculated by said energy calculating means. Support for the subject matter recited in claim 15 can be found variously throughout the specification and drawings, for example, at paragraphs [0086] through [0089] of corresponding U.S. Patent Application Publication No. 2002-0028028 (the '028 publication) and in Fig. 8 of the drawings. No new matter has been added.

Claims 1-15 are pending where claims 1, 11, 12, and 15 are independent.

Rejections Under 35 U.S.C. §112

Claims 2 and 3 were rejected under 35 U.S.C. §112, first paragraph as failing to comply with the written description requirement. Applicant acknowledges that this rejection was withdrawn as indicated in the Advisory Action issued dated June 9, 2005 (Paper No./Mail Date 20050531).

Claims 2 and 3 were rejected under 35 U.S.C. §112, second paragraph as indefinite. In particular, the final Office Action alleges that (1) the specification provides an example of a "loose connection" and a "tight connection," but fails to provide a clear definition of either term; and (2) it is not clear how the edge connecting process can be performed prior to the calculation of local energy. Applicant acknowledges that the rejection (1) concerning the definition of "loose connection" and "tight connection" was withdrawn as indicated in the Advisory Action

issued dated June 9, 2005 (Paper No./Mail Date 20050531). However, Applicant respectfully traverses the rejection (2) concerning the performance of the edge connecting process before the calculation of the local energy.

Claim 2 depends from claim 1 and further recites an edge conversion means for converting a loose connection of said original image into a tight connection before said energy calculating means calculates said local energy.

In section six (6) of the final rejection, the Office Action alleges that the subject matter of claim 2 contradicts the subject matter of claim 1 because paragraph [0174] of the '028 publication discusses that conversion of an edge from a "loose connection" to a "tight connection" requires prior knowledge of the edge direction.

Paragraph [0174] of the '028 publication states,

> "By performing the edge connecting process described above, it is possible to thicken a loosely connected edge such as that of an icon or a font so as to have a strong edge structure. For example, when an edge locally includes a loose connection formed of pixels lying on only two diagonal lines as shown in FIG. 32, there is a possibility that when an edge direction is detected by means of the edge direction calculation process in step S45 shown in FIG. 8 or the process in step S125 shown in FIG. 23, the edge direction is detected in a significantly wrong manner. **Such incorrect detection of the edge direction can cause the continuity of the edge to be destroyed. This problem can be effectively avoided by performing the edge connecting process described above** (emphasis added)."

There is no language in paragraph [0174] that teaches or suggests that performance of the edge connection process requires prior knowledge of edge direction as alleged in the final rejection. However, paragraph [0174] does provide examples of an expected result when an edge direction calculation is performed on a loosely connected edge. Evidence to support this interpretation of paragraph [0174] can be found through the language "[t]his problem can be effectively avoided by performing the edge connecting process." The problem of incorrect edge direction cannot be avoided if the edge connecting process is performed subsequent to the detection of edge direction.

In performing the edge connection, the right and left diagonal energies of a 2x2 block of pixels are calculated (See Fig. 30 elements S182 and S183). Paragraph [0166] describes calculating the right and left diagonal energies as follows:

> "The right diagonal energy is calculated by subtracting the pixel value of a lower left pixel of the 2.times.2 pixels from the pixel value of an upper right pixel, and the left

> diagonal energy is calculated by subtracting the pixel value of a lower right pixel from the pixel value of an upper left pixel."

As shown through Figs. 3, 5, 6, and 8 and discussed in the corresponding portions of the specification, the edge direction is calculated when the local energy is greater than a threshold T (*See* Fig. 8 elements S42-S45). Paragraph [0090] of the '028 publication describes calculating the local energy as follows:

> "[f]or each pair of pixels lying on a diagonal line, the pixel value of a pixel in a lower row is subtracted from the pixel value of a pixel in an upper row. The pixel value differences are calculated for the respective diagonal lines, and the sum of absolute values of the differences is employed as the local energy E(N)."

Based on at least the above discussion, Applicant respectfully submits that it should be readily apparent to one of ordinary skill in the art that the edge direction need not be known before the edge connection process is executed. The edge connection process does require the determination of right and left diagonal energies, however, these energies do not amount to the calculation of the local energy E(N), which leads to the calculation of the edge direction. As described above, the calculation of the local energy E(N) requires additional steps that are not performed during the calculation of the right and left diagonal energies. For at least these reasons, Applicant respectfully submits that the subject matter recited in claim 2 is definite, consistent with, and does not contradict the subject matter recited in claim 1. Accordingly, Applicant respectfully requests that the rejection of claim 2 under 35 U.S.C. §112, second paragraph be withdrawn.

Claim 3 depends from claim 2. By virtue of this dependency, Applicant submits that claim 3 is definite for at least the same reasons given above with respect to claim 2. Accordingly, Applicant respectfully requests, therefore, that the rejection of claim 3 under 35 U.S.C. §112, second paragraph be withdrawn.

Rejection Under 35 U.S.C. §102

Claims 1, 5-7, 11, and 12 were rejected under 35 U.S.C. §102(e) as anticipated by *Aoyama et al.*, U.S. Patent No. 6,535,651. Applicant respectfully traverses this rejection.

Claim 1 recites an image processing apparatus for converting the resolution of an original image in such a manner as to increase the spatial resolution of said original image by a factor of Z in each of vertical and horizontal directions, said image processing apparatus comprising energy calculating means for calculating local energy of said original image based on two rows of pixels in said original image; detection means for detecting the direction of an edge based on

said local energy calculated by said energy calculating means; interpolation means for interpolating a new pixel from a pixel of said original image based on the direction of the edge detected by said detection means; and edge enhancement means for performing an edge enhancement process based on said local energy calculated by said energy calculating means.

Claim 11 recites an image processing method of converting the resolution of an original image in such a manner as to increase the spatial resolution of said original image by a factor of Z in each of vertical and horizontal directions, said image processing method comprising the steps of calculating local energy of said original image based on two rows of pixels in said original image; detecting the direction of an edge based on said local energy calculated in said energy calculating step; interpolating a new pixel from a pixel of said original image based on the direction of the edge detected in said detection step; and performing an edge enhancement process based on said local energy calculated in said energy calculating step.

Claim 12 recites a storage medium storing a computer-readable program for controlling an image processing apparatus to convert the resolution of an original image in such a manner as to increase the spatial resolution of said original image by a factor of Z in each of vertical and horizontal directions, said program comprising the steps of calculating local energy of said original image based on two rows of pixels in said original image; detecting the direction of an edge based on said local energy calculated in said energy calculating step; interpolating a new pixel from a pixel of said original image based on the direction of the edge detected in said detection step; and performing an edge enhancement process based on said local energy calculated in said energy calculating step.

In summary, independent claims 1, 11, and 12 recite an apparatus, method, and program, respectively, that convert the resolution of an original image in such a manner as to increase the spatial resolution of said original image by a factor of Z in each of vertical and horizontal directions by, among other things, calculating local energy of said original image based on two rows of pixels in said original image. In performing this calculation, the pixel values of the respective pixels in the upper row are reduced by amounts of the pixel values of the corresponding pixels at the diagonal locations in the lower row, and the sum of the absolute values of those differences is determined. Using two rows of pixels in the original image provides an easier way for calculating local energy. In addition, using two rows of pixels enables processing that enlarges an edge in the vertical direction or horizontal direction.

Aoyama discloses an interpolating method and apparatus for processing image signals. The interpolating apparatus has an edge presence or absence judging means 31, a first interpolation operating means 40, and a second interpolating operating means 50. The edge presence or absence judging means 31 determines whether the interpolation point belongs to an edge portion or a flat portion. The first interpolating operation means 40 specifies the direction along which the image edge portion extends, and divides a unit lattice of the image into triangular regions with image edge serving as the boundary between the regions. The second interpolating operating means 50 inputs an instruction that alters the sharpness of a flat portion of the image along the exterior of the image. The interpolating method further calculates two an image density gradient vectors I and J. The difference between I and J is compared with a predetermined threshold value so that the direction along which the image portion of the image extends can be specified.

The final Office Action alleges that at col. 38, lines 7-8, *Aoyama* discloses calculating a local energy of an original image based on two rows of pixels. However, at this portion of the disclosure *Aoyama* merely discusses that an image density gradient may be calculated from the sum of the original image signal components. As discussed above, the image signal components correspond to individual lattice points of the image. Thus, the calculation of the image density gradient of *Aoyama* is not analogous to the local energy calculation, which as describe above includes calculating the pixel value differences for selected diagonal lines and summing the absolute values of the differences.

The final Office Action further alleges that Applicant's previous arguments concerning edge enhancement fail to comply with 37 CFR §1.111(b). However, in the previous response Applicant clearly detailed the reasons why *Aoyama* failed to disclose, teach, or suggest the calculation of local energy as recited in the claims.[1] Based on the reasons provided, Applicant concluded that based on the lack of the local energy calculation no edge enhancement was not performed. Though Applicant did not use this exact wording, the introduction of the last sentence using the phrase "in other words," is generally accepted as inferring that the previous

[1] "*Aoyama*, however, fails to disclose, teach, or suggest at least calculating local energy of said original image based on two rows of pixels in said original image, as recited in claims 1, 11, and 12. In contrast, *Aoyama* discloses that the image density is calculated from the unit lattice, and an edge determination is then performed. When the edge presence or absence judging means 31 determines that the image has no edge portion, the process of the second interpolating operating means 50 is carried out. In other words, *Aoyama* does not perform any edge enhancement operations." *See* Amendment in Response to Non-Final Office Action, October 18, 2004, page 11.

sentence or idea is being further developed or explained. For at least these reasons, Applicant's previous arguments fully comply with the provisions of 37 CFR §1.111.

To properly anticipate a claim, the document must disclose, explicitly or implicitly, each and every feature recited in the claim. *See* Verdegall Bros. v. Union Oil Co. of Calif., 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). *Aoyama* fails to disclose, teach, or suggest every element recited in independent claims 1, 11, and 12, therefore these claims are not anticipated by *Aoyama*. Accordingly, Applicant respectfully requests that the rejection of claims 1, 11, and 12 under 35 U.S.C. §102 be withdrawn, and these claims be allowed.

Claims 5-7 depend from claim 1. By virtue of this dependency, Applicant submits that claims 5-7 are allowable for at least the same reasons given above with respect to claim 1. In addition, Applicant submits that claims 5-7 are further distinguished over *Aoyama* by the additional elements recited therein, and particularly with respect to each claimed combination. Applicant respectfully requests, therefore, that the rejection of claims 5-7 under 35 U.S.C. §102 be withdrawn, and these claims be allowed.

Rejections Under 35 U.S.C. §103

Claims 2 and 3 were rejected under 35 U.S.C. §103(a) as unpatentable over *Aoyama* and further in view of *Klassen*, U.S. Patent No. 6,741,751. Applicant respectfully traverses this rejection.

Claims 2 and 3 depend from claim 1. By virtue of this dependency, Applicant submits that claims 2 and 3 are allowable for at least the same reasons given above with respect to claim 1. In addition, Applicant submits that claims 2 and 3 are further distinguished over *Aoyama* and *Klassen* by the additional elements recited therein, and particularly with respect to each claimed combination. Applicant respectfully requests, therefore, that the rejection of claims 2 and 3 under 35 U.S.C. §103 be withdrawn, and these claims be allowed.

Claims 4 and 14 were rejected under 35 U.S.C. §103 as unpatentable over *Aoyama* and further in view of *Moronaga et al.*, U.S. Patent No. 5,229,864. Applicant respectfully traverses this rejection.

Claim 4 depends from claim 1 and additionally recites when said calculated local energy is greater than a predetermined threshold value, said edge enhancement means performs a one-dimensional filtering process through a one-dimensional edge building filter such that the value of each pixel is multiplied by a corresponding coefficient of a plurality of coefficients and the products of each respective multiplication are added together, and wherein the one-dimensional edge building filter coefficients include a scaling factor. The Office Action acknowledges that *Aoyama* fails to disclose, teach, or suggest at least the elements of claim 4 and relies on *Moronaga* to remedy this deficiency.

Moronaga discloses that a one-dimensional filter, wherein the respective products of each multiplication are summed. Moreover, *Moronaga* discloses that the one dimensional filtering process is performed based on the amount of coded data Bxy. *Moronaga*, however, fails to disclose, teach, or suggest at least when said local energy is greater than a predetermined threshold value, said edge enhancement means performs a one-dimensional filtering process. In contrast, *Moronaga* discloses that the amount of coded data Bxy corresponds to the many high frequency components and coded data within the individual blocks of an 8x8 matrix. Applicant submits that the amount of coded data as disclosed by *Moronaga* is not analogous to the local energy of a pixel. Basing the one-dimensional filter process on the local energy, as recited in

claim 4, has the advantage of enabling the filtering process to be adapted for the surrounding pixels.

The final Office Action alleges that the high frequency components of an 8x8 matrix of pixels in *Moronaga* qualify as the local energy recited in claim 4. However, this alleged local energy of *Moronaga* is not calculated. In particular, the high frequency components disclosed in *Moronaga* are components of the original signal and are more analogous to the lattice points disclosed in *Aoyama*, which too are components of the original signal.

In summary, *Aoyama* and *Moronaga* either singly or combined fail to disclose teach or suggest at least when said **calculated local energy** is greater than a predetermined threshold value, said edge enhancement means performs a one-dimensional filtering process. At best, the combined references teach performing a one-dimensional filtering process when the amount of data within the individual blocks of an 8x8 matrix is greater than a predetermined threshold TH3. The disclosed amount of data of the references are components of the original image or signal and are not analogous to the **calculated local energy** as recited in the claim. Accordingly, a *prima facie* case for obviousness has not been established.

To establish *prima facie* obviousness of a claimed invention, all of the claim limitations must be taught or suggested by the prior art. In re Royka, 490 F.2d 981, 180 USPQ 580 (CCPA 1974). Moreover, obviousness "cannot be established by combining the teachings of the prior art to produce the claimed invention, absent some teaching or suggestion supporting the combination." ACS Hosp. Sys. V. Montefiore Hosp., 732 F.2d 1572, 1577, 221 USPQ 929, 933 (Fed. Cir. 1984). For at least the above reasons, Applicant respectfully requests that the rejection of claim 4 be withdrawn, and claim 4 be allowed.

Claim 14 depends from claim 4. By virtue of this dependency, Applicant submits that claim 14 is allowable for at least the same reasons given above with respect to claim 1. In addition, Applicant submits that claim 14 is further distinguished over *Aoyama* and *Moronaga* by the additional elements recited therein, and particularly with respect to the claimed combination. Applicant respectfully requests, therefore, that the rejection of claim 14 under 35 U.S.C. §103 be withdrawn, and this claim be allowed.

Claim 8 was rejected under 35 U.S.C. §103(a) as unpatentable over *Aoyama* and further in view of *Sato*, U.S. Patent No. 4,985,764. Applicant respectfully traverses this rejection.

Claim 8 depends from claim 1 and additionally recites said consistency judging means determines that a value obtained by multiplying a first difference and a second difference is negative, wherein the first difference is obtained by subtracting the new pixel value from the pixel value of a pixel located at the center of the upper row, and wherein the second difference is obtained by subtracting the pixel value of a pixel located at the center of the lower row from the new pixel value.

The Office Action acknowledges that *Aoyama* fails to disclose, teach, or suggest the elements recited in claim 8, and relies on *Sato* to remedy this deficiency.

Sato discloses an apparatus for detecting a pixel correlation and generating an interpolation signal for a digital television signal. In one embodiment, *Sato* discloses a process of preventing the degradation of picture quality through a minimum value detection section 6a, 6b, 6c, 6d, and 6e of correlation detection section 200. In these minimum value detection sections output signals from absolute value circuits are subtracted from each other to produce positive or negative polarity data. *Sato*, however, fails to disclose, teach, or suggest at least multiplying a first difference and a second difference is negative, wherein the first difference is obtained by subtracting the new pixel value from the pixel value of a pixel located at the center of the upper row, and wherein the second difference is obtained by subtracting the pixel value of a pixel located at the center of the lower row from the new pixel value. Namely, *Sato* fails to disclose, teach, or suggest a multiplication operation as recited in claim 8. Applicant requests that if *Sato* does in fact teach a multiplication operation as alleged in the final Office Action, the drawing element and corresponding portion of the specification that discusses the use of this multiplication operation be identified. Thus, even if *Aoyama* discloses a consistency determination as alleged in the final Office Action, which Applicant submits it does not, *Sato* still fails to remedy the acknowledged deficiencies. For at least the above reasons, *Aoyama* and *Sato* either singly or combined fail to teach every element recited in claim 8, a *prima facie* case for obviousness has not been established.

To establish *prima facie* obviousness of a claimed invention, all of the claim limitations must be taught or suggested by the prior art. In re Royka, 490 F.2d 981, 180 USPQ 580 (CCPA 1974). Moreover, obviousness "cannot be established by combining the teachings of the prior art to produce the claimed invention, absent some teaching or suggestion supporting the combination." ACS Hosp. Sys. V. Montefiore Hosp., 732 F.2d 1572, 1577, 221 USPQ 929, 933

(Fed. Cir. 1984). For at least the above reasons, Applicant respectfully requests that the rejection of claim 8 be withdrawn, and claim 8 be allowed.

Claims 9 and 13 were rejected under 35 U.S.C. §103(a) as unpatentable over *Aoyama* and in view of *Ng et al.*, U.S. Patent No. 5,450,531 and further in view of *Russ*, The Image Processing Handbook, 1995. Applicant respectfully traverses this rejection.

Claims 9 and 13 depend from claim 1. By virtue of this dependency, Applicant submits that claims 9 and 13 are allowable for at least the same reasons given above with respect to claim 1. In addition, Applicant submits that claims 9 and 13 are further distinguished over *Aoyama*, *Ng*, and *Russ* by the additional elements recited therein, and particularly with respect to each claimed combination. Applicant respectfully requests, therefore, that the rejection of claims 9 and 13 under 35 U.S.C. §103 be withdrawn, and these claims be allowed.

Newly Added Claim

Claim 15 recites an image processing apparatus for converting the resolution of an original image in such a manner as to increase the spatial resolution of said original image by a factor of Z in each of vertical and horizontal directions, said image processing apparatus comprising energy calculating means for calculating local energy of said original image based on two rows of pixels in said original image, wherein calculation of the local energy includes calculating differences between pixels of the two rows, calculating absolute values of the differences, and summing the absolute values of the differences; detection means for detecting the direction of an edge based on said local energy calculated by said energy calculating means; interpolation means for interpolating a new pixel from a pixel of said original image based on the direction of the edge detected by said detection means; and edge enhancement means for performing an edge enhancement process based on said local energy calculated by said energy calculating means. Applicant respectfully submits that claim 15 is allowable over the prior art of record. Accordingly, Applicant respectfully requests the claim 15 be examined and allowed.

Conclusion

Based on at least the foregoing amendments and remarks, Applicants submit that claims 1-15 are allowable, and this application is in condition for allowance. Accordingly, Applicants request favorable reexamination and reconsideration of the application. In the event the Examiner has any comments or suggestions for placing the application in even better form, Applicants request that the Examiner contact the undersigned attorney at the number listed below.

Applicant believes no fee is due with this response. However, if a fee is due, please charge our Deposit Account No. 18-0013, under Order No. SON-2199 from which the undersigned is authorized to draw.

Dated: July 8, 2005

Respectfully submitted,

By_____
Ronald P. Kananen
Registration No.: 24,104
Shawn B. Cage
Registration No.: 51,522
Attorneys for Applicant

RADER, FISHMAN & GRAUER, PLLC
Lion Building
1233 20th Street, N.W., Suite 501
Washington, D.C. 20036
Tel: (202) 955-3750
Fax: (202) 955-3751
Customer No. 23353

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